



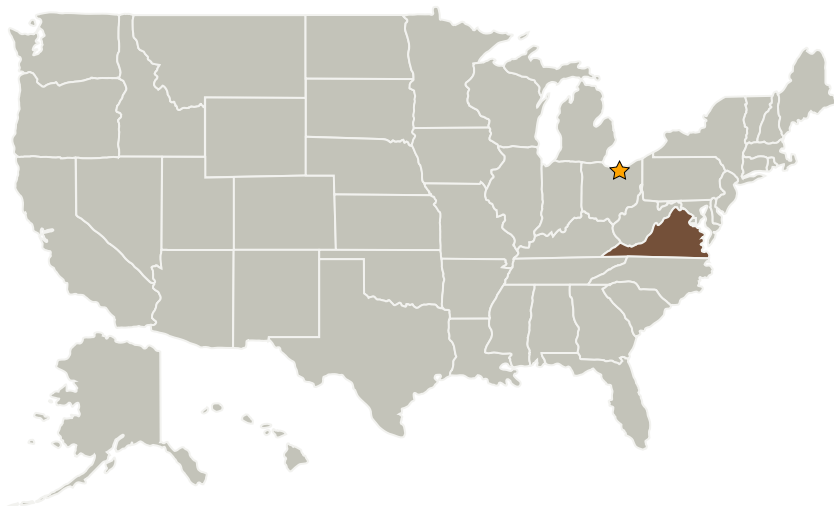
Project Introduction

The Turbulence, Transition, and Numerical Method Technologies effort identifies and down-selects critical turbulence, transition, and numerical method capability improvements that enable at least a 40% reduction in predictive error against standard test cases. The project will examine turbulent separated flows, evolution of free shear flows, and shock-boundary layer interactions utilizing state-of-the-art high performance computing hardware.

Anticipated Benefits

The development of physics-based computational tools envisioned in Revolutionary Computational Aerosciences will yield a number of benefits: deliver a capability to the aeronautics community to improve designs and reduce design cycle times; accelerate introduction of advanced air vehicles and propulsion systems into the airspace system; enable simulation and certification by analysis, thereby reducing flight testing and resulting in savings of up to \$1B from an aircraft development program.

Primary U.S. Work Locations and Key Partners



Transformative Aeronautics Concepts Program (TACP)

Turbulence, Transition, and Numerical Method Technologies

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Organizations Performing Work	Role	Type	Location
★ Glenn Research Center(GRC)	Lead Organization	NASA Center	Cleveland, Ohio
Air Force Research Laboratory(AFRL)	Supporting Organization	US Government	Notre Dame, Indiana
Massachusetts Institute of Technology(MIT)	Supporting Organization	Academia	Cambridge, Massachusetts
Old Dominion University	Supporting Organization	Academia	Norfolk, Virginia
Stanford University(Stanford)	Supporting Organization	Academia	Stanford, California
The University of Texas at Austin	Supporting Organization	Academia	Austin, Texas
University of Illinois at Urbana-Champaign	Supporting Organization	Academia	Urbana, Illinois
University of Notre Dame(Notre Dame)	Supporting Organization	Academia	Notre Dame, Indiana
University of Wyoming	Supporting Organization	Academia	Laramie, Wyoming

Primary U.S. Work Locations

Virginia

Project Transitions

**October 2013:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Aeronautics Research Mission Directorate (ARMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

Transformative Aeronautics Concepts Program

Project Management

Program Director:

John A Cavolowsky

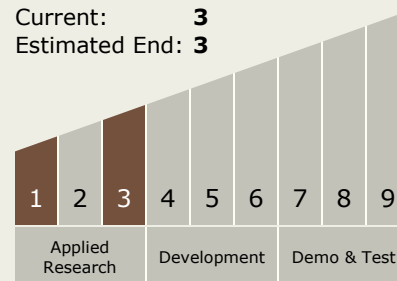
Project Manager:

Michael M Rogers

Principal Investigator:

Mujeeb R Malik

Technology Maturity (TRL)

Start: **1**Current: **3**Estimated End: **3**



✓ May 2018: Closed out

Closeout Summary: The close collaboration in the validation experimentation effort was excellent, the complementary research efforts related to fundamental numerical model development, and the activities related to effective HPC utilization on near term architectures that are coming down the pipeline were exactly what NASA should be doing. Even though the TQR panel cannot say that the success criteria were fully met, we do feel that the research funded by TTT/RCA was successful and useful in determining the next suite of CFD validation tests and the problematic flow conditions that continue to be difficult to predict using our current suite of computational tools. Given the TQR Panel's review criteria: 1. The deliverables meet the technical requirements; 2. The appropriate technical approaches were followed in producing the deliverables; and 3. All technical caveats and concerns have been identified and the deliverables: *a.* Development of more accurate physics-based methods (e.g., higher moment closure); *b.* Large eddy simulation (LES); *c.* Advanced numerical methods; *d.* Transition prediction and modeling; *e.* Validation experiments; *f.* Multidisciplinary analysis and design (high fidelity). TQR panel feels that the technical processes were all completed and that the review criteria and all the deliverables were met. Thus, the Milestone TACP-2 016-001 has been completed.

Project Website:

<https://www.nasa.gov/aeroresearch/programs/tacp/ttt>

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
 - ↳ TX15.1 Aerosciences
 - ↳ TX15.1.7 Computational Fluid Dynamics (CFD) Technologies

Target Destination

Foundational Knowledge